PATENT SPECIFICATION (11) 1 404 899

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(21) Application No. 17547/73 (22) Filed 12 April 1973 (19)
(31) Convention Application No. 255 079 (32) Filed 19 May 1972 in
(33) United States of America (US)
(44) Complete Specification published 3 Sept. 1975
(51) INT. CL.[2] A21D 2/26 2/36
(52) Index at acceptance
A2B 1B 1D 1G 1JY 1K 1L 1Z

(54) A BREAD DOUGH AND BREAD PRODUCED THEREFROM

(71) We, INTERNATIONAL FOOD TECHNOLOGY, INCORPORATED, a corporation organised and existing under the laws of the State of Delaware, United States of America, of Post Office Box 298, Hillsdale, New York 12529, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a bread dough and to bread produced therefrom. More particularly, the invention relates to a bread dough including large amounts of a highly proteinaceous non-wheat protein source relatively rich in at least one essential amino acid, such as L-lysine, in which wheat protein is relatively deficient.

Many years ago it was demonstrated that wheat protein is deficient in L-lysine. It has therefore been proposed to add L-lysine to bread formulations and, more recently, to add less expensive L-lysine sources such as soy flour. Similarly, it has been proposed to add non-wheat protein sources to supply other essential amino acids such as threonine, methionine, and the like in which wheat protein is relatively deficient. There are, however, two basic problems which result from the use of non-wheat protein in bread in an amount sufficient to substantially alter the protein quality. First, the non-wheat protein, being non-glutenaceous, "burdens" the dough formulation resulting in bread having poor physical characteristics. Second, the non-wheat protein imparts a non-wheat taste which, in the case of the otherwise most eminently suitable wheat flour substitutes—namely soy fluor and/or fish flour—is very objectionable, particularly where the non-wheat proteins are used in a relatively large amount of at least 6 percent by weight based on the weight of the wheat flour.

The first problem is met by using a lesser amount of non-wheat protein (with consequent reduction in the improvement of protein quality) and/or by using special additives which enhance tolerance for non-wheat protein. The second problem, however, is one which is largely unsolved.

[*Price 33p*]

It is an object of the present invention to provide bread having large amounts of non-wheat protein. It is a further object to provide such bread having at least 6 percent by weight, based on the weight of wheat flour, of one or more highly proteinaceous non-wheat protein sources. The term "highly proteinaceous" is used herein to mean that at least 50 percent by weight of the protein source is protein. It is still a further object to provide such bread which is free from the disadvantages noted above.

The present invention provides a bread dough comprising wheat flour, a highly proteinaceous (as hereinbefore defined) non-wheat source of a protein selected from the group consisting of bean protein and fish protein, the non-wheat source of protein being present in an amount of from 6 to 15 percent by weight based on the weight of wheat flour, and a corn material selected from the group consisting of corn meal and corn flour in the amount of from 1 to 8 percent by weight based on the weight of the wheat flour, such that the flavour of bread made from said dough is substantially the same as dough made solely from wheat flour without noticeable flavour of said protein source or of said corn material.

Particularly good results are obtained from a bread dough in which the non-wheat protein source is present in amounts of from 6 to 12 percent by weight based on the weight of the wheat flour or the corn material is present in amounts of from 2 to 6 percent by weight based on the weight of the wheat flour.

Carboxymethylcellulose and/or one or more other permitted food additives may be used optionally to assist the formulation to tolerate the burden imposed by the non-wheat protein.

The bread dough to which the invention relates may be made in any conventional way such as straight dough, sponge dough, "no-time" dough, continuous mix, and known variations of these basic methods. The wheat flour used in the formulation is conventional wheat flour for bread making. While the dough is referred to herein as bread dough, it will be apparent that the

dough is also useful for making buns, rolls, and the like.

While wheat flour has the unique property of forming gluten gel when mixed with water, a feature essential to bread making, the ratio of utilizable-protein calories to total calories (called "protein quality") is low. It has been recognized for many years that this ratio can be increased by adding to the bread dough one or more of the essential amino acids in which wheat protein is deficient. The largest deficiency is in respect to L-lysine and, by adding L-lysine to the bread dough, the utilizable protein of the bread is increased and the ratio of utilizable-protein calories to total calories is increased by more than the amount added by the L-lysine. After the deficiency of L-lysine is eliminated, another essential amino acid deficiency becomes controlling and a further increase in protein quality is obtained by adding that particularl acid. Additions of the acids themselves is inherently expensive and, furthermore, since wheat protein is relatively deficient in several essential amino acids, it would be preferable to add a raw protein source and, in particular, one which is relatively rich in those essential amino acids which are relatively deficient in wheat protein. The efficient raw protein sources, from a technical point of view, would be those which were rich in those essential amino acids in an amount proportional to their deficiency in wheat protein. However, cost factors are of much more importance. Accordingly, the non-wheat protein sources used in the bread dough are those which are relatively rich, upon hydrolysis, in essential amino acids in which wheat protein is relatively deficient. By "relatively rich" and "relatively deficient" are meant the amount of the acids in question relative to that which can be utilized by a human consuming the protein in question. In other words, a protein rich in L-lysine includes an amount of L-lysine above the amount in a given protein which can be utilized by a human consuming that protein. Preferably, the non-wheat protein is relatively rich primarily in L-lysine and the present preferred non-wheat protein sources are soy and fish.

Soy is the preferred non-wheat protein source and soy flour is the preferred soy material. Any of the conventional edible grades of soy flour may be used ranging in fat content from 18 to 22 percent by weight fat in the full fat grade, to 1 percent or less in the defatted flours. Where fish is used, fish protein concentrate is the preferred fish material and any edible grade may be used. It is preferable to use defatted soy flour, although full fat soy flour can be used since it is available as a stable, finely milled flour. It is preferable that the soy flour be toasted, as toasting improves its flavour and renders it more digestible by inactivating antitrypsin enzymes usually present in soy flour. The term "soy flour" as used in the present specification includes defatted and full fat soy flour, soy protein concentrate and isolated soy protein, preferably milled to a particle size which will pass through an 80 mesh screen (U.S. standard).

The corn material used according to the invention can be any edible grade of corn flour or corn meal. Corn flour is preferred and, if corn meal is used, it is preferably used in an amount of from 1 to 4 percent by weight.

It has been known for some time that the addition of a non-wheat protein source, such as soy flour, into a bread dough, "burdens" the bread which results in poor physical and eating qualities. Large quantities of soy flour, for example, cannot be readily incorporated into a bread dough. However, it will be remembered that the object of adding the non-wheat protein source is to add a source of essential amino acid in which the additive is rich and in which the wheat protein is deficient. This means, in practice, that relatively large amount of non-wheat protein, generally at least 6 parts by weight per hundred parts by weight of wheat flour, must be added to obtain a substantial increase in protein quality. The addition of this large amount of non-wheat protein generally results in poor bread quality and various additives, generally classed as "conditioners", "emulsifiers" or "softeners" in the baking industry, have been proposed to remedy this defect. Among the proposed additives are sodium stearoyl-2-lactylate and calcium stearoyl-2-lactylate. However, these are expensive materials and they are used in relatively large amounts. It is therefore preferred to use materials which can be used in lesser amounts and/or at lesser expense. We have found several other materials which can be so used including conventional mono-and diglyceride bread additives such as "Atmul 500" and cellulose ethers such as sodium carboxymethylcellulose in amounts up to 0.5 percent based on the wheat flour weight.

The bread formulation also preferably includes essential vitamins and minerals to provide an enriched bread.

This invention extends to bread made from a dough of the invention.

Several examples of bread doughs according to the invention will now be described, though by way of illustration only.

EXAMPLES 1 and 2

A bread dough according to the invention is made by the sponge dough technique from the following formulation:

Ingredient	Percent by weight based on total wheat flour weight
Sponge:	
Wheat flour	62.5
Water	46.0
Yeast food (flour, salt, NH_4Cl, $CaSO_4$, $KBrO_3$)	0.5
Yeast	2.5
Dough:	
Wheat flour	37.5
Water	36.0
Sugar (Sucrose)	7.0
Salt (Regular)	2.0
Shortening (Vegetable)	3.0
Ca Propionate	0.1
Hofmann-LaRoche Vitamin Mix ("Roche" is a Registered Trade Mark)	1.25
L-lysine monohydrochloride (Ajinomoto)	0.25
Fish Protein Concentrate (U.S. Department of Commerce 90% protein)	2.0
Nonfat Dry Milk	2.0
Soy flour (Central Soya "Textrol")	6.0
Corn flour ("Ceredex 265" Illinois Cereal Mills) ("Ceredex" is a Registered Trade Mark)	5.0
Emulsifier ("Atmul 500" Atlas Chemical Products)	0.2
Sodium CMC (DuPont P-95-SM Carboxymethylcellulose)	0.1

The process conditions are as follows:
Sponge formulation time: 4 hours
Sponge temperature (into fermenter): 78°F
Sponge temperature (out of fermenter): 84°F
Dough mixing time: 7 minutes
Dough temperature: 85°F
Dough proofing time: 55 minutes
Dough Scaling Weight: 430 grams

The dough is baked at 400°F for 18 minutes. The baked bread weighs 387 grams with a volume of 1900 cc, or a vol./wt. ratio of 4.90; crumb color is yellow; grain is rather open with round cells. The flavour is without noticeable soy taste, fish taste, or corn taste. A second sample is made in the same manner except that the corn flour is omitted. Process conditions are substantially identical. The baked bread has a slight non-wheat flour taste imparted by the soy flour and fish protein concentrate.

EXAMPLES 3 and 4

Bread according to the invention is made by the sponge dough technique from the following formulation:

Ingredient	Percent by weight based on total wheat flour weight
Sponge:	
Wheat flour	62.5
Water	46.0
Yeast food	0.5
Yeast	2.5
Dough:	
Wheat flour	37.5
Water	36.0
Sugar ("Cerelose", dextrose)	8.5
Salt (Regular)	2.25
Shortening (Vegetable)	3.0
Ca Propionate	0.25
Hoffman-LaRoche Vitamin Mix	1.25
L-lysine HCl (Ajinomoto Co.)	0.25
Fish Protein Concentrate (U.S. Department of Commerce)	2.0
Soy flour ("Textrol", Central Soya)	7.0
Corn flour ("Ceredex" Illinois Cereal Mills)	5.0
Sodium CMC (Dupont P-95-SM)	0.2

The processing conditions are as follows:
Sponge fermentation time: 4 hours
Sponge temperature (out): 85.5°F
Weight of dough: 214.7 lbs
Dough mixing time: 7 minutes
Dough temperature: 82°F
Average proofing time: 54 minutes
Bake time: 18 minutes at 400°F.

Results are similar to those of Example 1. A fourth example is made in the same manner as Example 3 except that the corn flour is omitted. The process conditions are substantially the same and the results are similar to Example 3; there is a noticeable "penetration" of soy and fish protein taste which is lacking in the baked bread of Example 3.

EXAMPLES 5 and 6

Bread is made according to the straight dough method from the following formulation:

Ingredient	Percent by weight based on wheat flour weight
Brew:	
Water	68
Salt	0.75
Sugar	1.0
Yeast	2.5
Yeast food	0.66

The brew is left for 1 hour and 45 minutes during which time the temperature rises from 80 to 87° with about 2.0 percent weight loss. The pH is monitored by litmus and is about 4.9. The brew is then placed in the

mixer with the remainder of the formulation as follows:

Brew	72.91 lbs
Water	20 lbs
Flour	100 lbs
	% by weight based on wheat flow weight
Sugar	7.5
Salt	1.50
Shortening	3.0
Ca Propionate	0.25
Hoffman-LaRoche Vitamin Mix	1.25
L-lysine monohydrochloride	0.25
Soy fluor ("Textrol")	10.0
Corn fluor ("Ceredex 265")	5.0
CMC (P-75-SM)	0.2
Emulsifier ("Xpando", a polyoxyethylene glyceride type)	0.25
$KBrO_3$ wafer	(60 parts by weight per million parts by weight of wheat flour)

The formulation is mixed for one minute a low speed and to "clean up" (10 minutes) at high speed. Dough temperature is 80—82°F. The dough is proofed for 60 minutes as 105°F, 90 percent relative humidity and baked for 10 minutes at 425°F. Results are similar to those of Example 3. The baked bread lacked any flavor of soy or corn. A sixth sample is made as in Example 5 except that the corn flour is omitted. The baked bread has the characteristic color and beany taste associated with breads having 10 percent by weight of soy flour.

Example 7

Bread is made by the srtaight dough method as in Example 5, with the following changes:

1) Corn flour is 7 percent
2) soy fluor is 8 percent and "Ardex 550", a 52 percent protein soy flour is used
3) Gluten flour, in an amount of 1 percent, is added to the mix
4) "Sour dough base", in an amount of 1 percent, is added to the mix

("Sour dough base" is a mold inhibitor sold by Breddo Food Products Corporation). The bread is very good in appearance and eating quality. A very slight corn taste is detectable, but no beany taste is noticeable. Loaf volume is very good.

Example 8

Bread is made as in Example 7 with the following changes:

1) Corn flour is 3 percent
4) Soy flour is 12 percent

The beany taste of the soy is noticeable and the crumb is sticky. Loaf volume, however, is very good.

In the previous examples, pre-gelatinized corn flour is employed. In several of the following examples, other forms of corn are employed.

Example 9

Bread is made as in Example 8 except for the following changes:

1) Corn meal is substituted for corn flour, the amount of corn meal being 5 percent
2) Soy flour is 8 percent
3) Gluten flour is omitted
4) CMC is increased to 0.25 percent
5) High speed mixing is 12 and one half minutes

The bread has a noticeable yellow color and a slight corn taste but has good loaf volume, good eating properties and no beany taste.

Example 10

Bread is made as in Example 9 except for the following changes:

1) Pre-gelatinized corn flour, in an amount of 5 percent, is substituted for the corn meal
2) The soy is changed to "Nutri Soy", a 53 percent protein soy flow produced by ADM

Results are excellent. The bread has good loaf volume, colour and flavor.

Example 11

Bread is made as in Example 10 except for the following changes:

1) The amount of sugar is increased to 10 percent
2) The amount of L-lysine is increased to 0.3 percent

Results are excellent. A production bread sample made in a commercial bakery equipment contains 12.3 percent protein, 42.1 percent water and has a protein efficiency ratio (PER) of 2.29 as compared to a casein value of 2.68 for control animals. Loaf volume, color, and taste are also very good. The yield from 165 pounds of wheat flour is 302 one pound loaves.

Example 12

Bread is made as in Example 11 except for the following changes:

1) Dry milled yellow corn flour is substituted for the pre-gelatinized corn flour
2) A 52 percent protein soy flour ("200-T" Central Soya) is substituted for the Nutri Soy
3) The "sour dough base" is omitted

Results are similar to Examples 10 and 11. The color, surprisingly, is similar to Examples 10 and 11. The dough gives a one kilogram loaf of bread in a standard 2 pound "Pullman loaf" ("Pullman" is a Registered

Trade Mark) size pan and this loaf scored 94.40 by the QBA method in which it is judged superior in flavor and eating quality. Two defects (crust and holes in the grain) were also noted in the test but these are easily correctable by baking techniques. The net result of having two plusses and two defects is an average score and the loaf can be made above average by charging processing techniques, such as baking temperature and mixing time, in a known manner.

EXAMPLE 13

Bread is made as in Example 12 except that the amount of corn flour is reduced to 1 percent. Bread quality is good except that there is a noticeable beany taste.

EXAMPLE 14

Bread is made by the "no-time" dough method from the following formulation:

Ingredient	Percent by weight based on total wheat flour weight
Wheat flour (with 100 ppm ascorbic acid)	100
corn flour (Ceredex 265)	4.55
soy flour (Ardex 550)	7.74
cane sugar	7.28
salt	1.82
shortening (margarine)	2.73
yeast	2.73
L-lysine HCl	0.27
CMC	0.23
Ca Propionate	0.27
Hoffman-LaRoche Vitamin Mix	1.09
Water	.89
Conditioner ("Hacko-200", a polyoxyethylene glyceride conditioning emulsifier)	0.23
Yeast food	0.68

The dough is mixed for three and one half minutes (115 watt hours) in a Tweedy Co. mixer (Model No. 280 fitted with its internal wall baffles and bread making agitator plates). The dough is then divided rounded, overhead proofed for 12 minutes, molded, panned, and proofed for 80 minutes at 105°F, and baked 22 minutes at 405°F. Results are excellent.

The bread of the invention meets the objective of 12 percent minimum for utilizable-protein calories based on total calories. Sime bread samples are as high as 18 percent. Furthermore, the bread of the invention toasts very well.

As mentioned above, a principal object of the invention is to provide a bread having enhanced protein quality (i.e. the ratio of utilizable protein calories to total calories in the bread). For this purpose, the amount of non-wheat proteinaceous source is between 6 and 15 percent by weight based on the wheat flour weight. The amount of corn flour used according to the invention is from 1 to 8 percent by weight, same basis. Where corn meal is used, the maximum amount is preferably 4 percent. The preferred non-wheat protein source includes soy and fish and preferred amount of these are between 6 and 12 percent by weight, in which case the amount of corn flour is preferably from 2 to 6 percent by weight.

Essential amino acids can also be added the L-lysine is preferred. In general, L-lysine may be added in an amount of up to 1 percent by weight based on the wheat flour weight, and preferably in an amount of up to 1/2 percent by weight.

As indicated in the Examples, essential vitamins and minerals may be added to the dough.

Compared with standard breads, bread of the present invention is lower in calories and higher in vital protein-building nitrogen. It has a much higher (12 percent) ratio of usable-protein to total calories. It also may be enriched with all of the 19 essential vitamins and minerals listed in the Federal Register, March 30, 1972 by the Food and Drug Administration from the National Academy of Sciences "Recommended Dietary Allowances". Analysis of a typical bread in accordance with the invention is shown in the following table:

Nutrient	Fraction of Recommended Dietary Allowance: One-meal Serving (two slices)	Daily Intake (eight slices)
Vitamin A	10%	40%
Vitamin C	15	50
Thiamine (Vitamin B_1)	15	60
Riboflavin (Vitamin B_2)	10	50
Niacin	10	40
Calcium	10	30
Iron	15	50
Vitamin D	10	40
Vitamin E	10	30
Vitamine B_6	10	40
Folacin (Folic Acid)	10	30
Vitamin B_{12}	10	30
Biotin	10	30
Pantothenic Acid	10	30
Phosphorus	10	30
Iodine	10	40
Zinc	10	30
Magnesium	10	40
Copper 15	15	50

The protein quality of a typical bread in accordance with the present invention is indicated in the following table:

Serving sizes:	One Meal 2 slices (Approx. 2 ounces, or 57 grams)	Daily Intake 8 slices (Approx. 8 ounces, or 227 grams)
Contents:		
Calories	130	510
Grams Total Protein	6	23
Grams Casein-Equivalent Protein	5	18
Grams Fat	2	6
Grams Available Carbohydrate	23	91

As mentioned above, soy is the preferred non-wheat protein source and defatted soy flour having a protein content of at least 50 percent is the preferred soy material.

Vitamin C (ascorbic acid) may be sprayed onto the bread as an aqueous solution after slicing and before packaging. The package in this case is a gas tight plastic film such as polyolefin film. In order to preserve the ascorbic acid from oxidation, the package is preferably provided with an atmosphere of inert gas such as nitrogen. In normal practice, the empty packages are opened with air prior to insertion of the bread loaf. Nitrogen is preferably provided in the package by using nitrogen, in lieu of air, to inflate the empty package.

WHAT WE CLAIM IS:—

1. A bread dough comprising wheat flour, a highly proteinaceous (as hereinbefore defined) non-wheat source of a protein selected from the group consisting of bean protein and fish protein, the non-wheat source of protein being present in an amount of from 6 to 15 persent by weight based on the weight of wheat flour, and a corn material selected from the group consisting of corn meal and corn flour in the amount of from 1 to 8 percent by weight based on the weight of the wheat flour, such that the flavour of bread made from said dough is substantially the same as dough made solely from wheat flour, without noticeable flavour of said protein source or of said corn material.

2. A bread dough as claimed in Claim 1 wherein said non-wheat protein source is present in an amount of from 6 to 12 percent by weight based on the weight of wheat flour.

3. A bread dough as claimed in Claims 1 or 2 wherein said corn material is present in an amount of from 2 to 6 percent by weight based on the weight of the wheat flour.

4. A bread dough according to any preceding claim wherein said corn material is corn flour.

5. A bread dough according to Claim 4 wherein said corn flour is pre-gelatinized corn flour.

6. A bread dough according to Claim 4 wherein said corn flour is dry milled corn flour.

7. A bread dough according to any preceding claim wherein said non-wheat protein source is a source of soy protein.

8. A bread dough according to Claim 7 wherein said soy protein comprises soy flour.

9. A bread dough according to any preceding claim including up to 0.5 percent by weight, based on the wheat flour weight, of sodium-carboxymethylcellulose.

10. A bread dough as claimed in any preceding claim and substantially as hereinbefore described.

11. Bread produced from a bread dough as claimed in any of the preceding claims.

CRUIKSHANK & FAIRWEATHER,
19 Royal Exchange Square,
Glasgow, G1 3AE.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1975
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.